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STOCK ASSESSMENT OF SUBDIVISION 3Ps COD, OCTOBER 2011

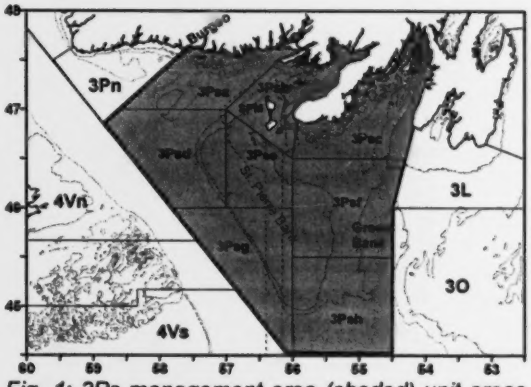

Fig. 1: 3Ps management area (shaded) unit areas (solid lines) and economic zone around the French islands of St. Pierre and Miquelon (SPM) (dashed line).

Context

In the Northwest Atlantic, cod are distributed from Greenland to Cape Hatteras and are managed as 12 stocks. The 3Ps stock off southern Newfoundland extends from Cape St. Mary's to just west of Burgeo Bank, and over St. Pierre Bank and most of Green Bank (Fig. 1).

The distribution of 3Ps cod does not conform well to management boundaries and the stock is considered a complex mixture of inshore and offshore sub-components. These may include fish that move seasonally between adjacent areas as well as fish that migrate seasonally between inshore and offshore. The extent to which the different components contribute to the fisheries is not fully understood.

Cod from this stock generally grow faster than those from areas further northward. Female cod from this stock are generally maturing at younger ages in recent years. For example, about 35% of the females are mature by age 5 (~47 cm) in recent cohorts, compared to only about 10% at age 5 (~55 cm) among cohorts present in the 1970s-early 1980s.

Catches from this stock have supported an inshore fixed gear fishery for centuries and are of vital importance to the area. Fish are caught offshore by mobile and fixed gear, and inshore by fixed gear only. Spanish and other non-Canadian fleets heavily exploited the stock in the 1960s and early 1970s. French catches increased in the offshore throughout the 1980s. A moratorium on fishing initiated in August 1993 ended in 1997 with a quota set at 10,000 t. Beginning in 2000, the management year was changed to begin on 1 April. The TAC for the 2010/11 and 2011/12 management years was set at 11,500 t. Under the terms of a 1994 Canada-France agreement, the French (St. Pierre et Miquelon) share of the TAC is 15.6%.

The present assessment is the result of a request for science advice from the Fisheries and Aquaculture Management (FAM) Branch (NL Region). The main objectives were to evaluate the status of the stock and to provide scientific advice concerning conservation outcomes related to various fishery management options.

Participants included DFO scientists, a scientist from IFREMER (France), fisheries managers, academia, government officials from the province of Newfoundland and Labrador, fishing industry representatives, and World Wildlife Fund (Canada).

SUMMARY

- Information available to evaluate stock status consisted of commercial landings (1959 to 2010) and log-book data (1997-2010) in conjunction with information from Canadian research vessel (RV) trawl surveys (1972-2011), sentinel surveys (1995-2011), and a telephone survey of Canadian fish harvesters pertaining to the 2010/11 fishery. Exploitation (harvest) rates were estimated from tagging experiments in Placentia Bay. Consistent with recent assessments, a survey based cohort model (SURBA) was used.

- The total allowable catch (TAC) for the 2009/10 and 2010/11 management years was 11, 500 t. Reported landings during the 2009/10 and 2010/11 seasons totaled 77% and 68% of the TAC, respectively. This is atypical.

- Tagging data and ancillary information indicated that there is a complex of stock components in 3Ps. However, the DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends.

- Gillnet catch rates from both sentinel surveys and logbooks for vessels <35' suggest stability. However, linetrawl catch rates from these sources indicate recent decline.

- Exploitation rates for 2010 based on tagged cod released in Placentia Bay ranged from 28-33% for large cod (>65cm) and 10-17% for smaller cod (<65cm).

- Estimates of total mortality (ages 5-10) over 2006-10 averaged 0.68 (49% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

- The basis for a limit reference point (LRP) for this stock is $B_{Recovery}$, defined as the lowest observed SSB from which there has been a sustained recovery. The 1994 value of SSB has been identified as the limit reference level for this stock.

- SSB decreased over the 2004-09 period. The SSB was estimated to be below the LRP during 2008 and 2009. The spawning stock biomass (SSB) in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08).

- A one year projection to 2012 using the cohort model indicated that survey SSB will continue to increase if total mortality is similar to current values (i.e., within ±20%). This increase is due to the recruitment of the relatively strong 2006 year class (YC) to the spawner biomass. The projection also indicated that the probability of being below the LRP in 2012 is low (0.02 to 0.09).

- A three year projection to 2014 indicates subsequent declines in both total biomass and spawning biomass if total mortality is similar to current values (i.e., within ±20%). In 2014 the probability of being below the LRP ranges from 0.03 to 0.56.
- The 2006 cohort is estimated to be relatively strong and is expected to recruit to the 2011 fishery. The 2007 to 2009 cohorts are estimated to be near the 1982-2010 average.

INTRODUCTION

History of the fishery

The stock was heavily exploited in the 1960s and early 1970s by non-Canadian fleets, mainly from Spain, with catches peaking at 84,000 t in 1961 (Fig. 2).

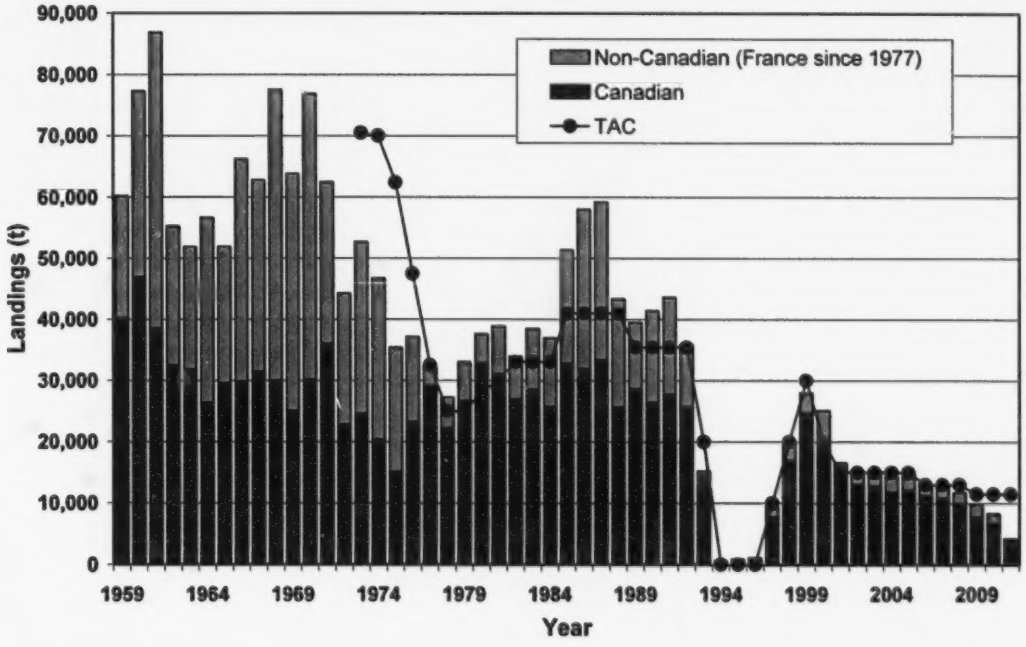

Fig. 2. Reported calendar year landings (t) of cod in 3Ps, 1959-2011 (2011/12 fishing season ongoing). Note that since 2000 TAC's are by management year (1 April-31 March).

After the extension of jurisdiction in 1977, catches averaged around 30,000 t until the mid-1980s when fishing effort by France increased and total landings reached about 59,000 t in 1987. Catches then declined gradually to 36,000 t in 1992.

A moratorium was imposed in August 1993 after only 15,000 t had been landed. Although offshore landings fluctuated, the inshore fixed gear fishery reported landings around 20,000 t each year up until the moratorium.

The fishery reopened in May 1997 with a TAC of 10,000 t. This was subsequently increased to 20,000 t for 1998 and to 30,000 t for 1999. In 2000 the management year was changed to begin on 1 April. An interim quota of 6,000 t was set for the first three months of 2000. Subsequent TACs are shown in Table 1. The TAC for the 2011/12 management year was set at 11,500 t.

Landings

Management Year	02-03	03-04	04-05	05-06	06-07	07-08[1]	08-09[1]	09-10[1]	10-11[1]	11-12[1,2]
TAC[3]	15.0	15.0	15.0	15.0	13.0	13.0	13.0	11.5	11.5	11.5
Canada	12.5	12.6	12.1	11.7	11.3	10.8[4]	10.6[4]	7.5[4]	6.6[4]	2.4[4]
France	2.3	2.4	2.4	2.2	1.9	2.0	2.0	1.5	1.3	0.2
Totals	14.8	15.0	14.5	13.9	13.2	12.8	12.6	9.0	7.8	2.6

Table 1: Landings by management year in NAFO Subdivision 3Ps (nearest thousand metric tons).

[1] Provisional.

[2] Approximate landings to 30 September 2011.

[3] TAC is shared between Canada (84.4%) and France (St. Pierre and Miquelon; 15.6%).

[4] Does not include Canadian recreational fisheries.

In the 2009/10 management year, total reported landings were 8,900 t, or 77% of the TAC. During the 2010/11 season, total reported landings were 7,800 t, just 68% of the available TAC. These differences between the TAC and landings are unusual; normally the entire TAC is utilized. Participants from industry indicated multiple reasons which contributed to this change: reduced profitability, additional market considerations, a labour disruption in one fleet sector, and a reduction in the availability of large fish offshore during winter 2011. The total 2010/11 landings includes French landings of 1,251 t, approximately 94% of which was caught by otter trawlers. Sentinel surveys removed a total of 17 t.

Provisional data (as of Sept 30 2011) indicate total landings during the ongoing 2011/12 management year were approximately 2,600 t, 200 t of which was landed by France. Sentinel surveys have landed nine tons to date.

The level of total removals is uncertain. It is likely that historical landings have been biased both upwards (e.g., due to misreporting of catch by area and/or species) and downwards (e.g., due to discarding). In addition, commercial catch accounting procedures pre- and post-moratorium are radically different, with current measures likely to provide improved estimates of removals. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium. Estimates of recreational fishery landings have not been available since 2006.

During the calendar year 2010, most of the catch was taken by gillnets and although a wide range of ages were captured, 80% of the landings comprised of ages 5-8 cod.

Species Biology

Stock structure and **migration patterns** of 3Ps cod are complex. Cod in 3Ps mix with adjacent stocks at the margins of the stock boundary. Some offshore components of the stock migrate seasonally to inshore areas, and there are inshore components that are shoreward of the spring DFO RV trawl survey area. These features can add uncertainty to the assessment of stock status. However, since the moratorium, new information has been obtained from various

sources, including tagging, acoustic telemetry, and the sentinel fishery. This information has provided a basis for several new measures to be put in place to reduce the potential impact of these factors (i.e., stock structure and migration patterms) on the assessment. Survey timing has been delayed until April and winter area closures have been imposed to reduce the possibility that migrant non-3Ps cod are included in surveys and commercial catches. Catches of cod in neighbouring stock areas (3Pn4R and southern 3L) have also been reduced in recent years such that exploitation of migrant 3Ps cod and their inclusion in non-3Ps catches has likely been reduced. The area surveyed during the spring DFO RV trawl survey has also been extended shoreward and total area coverage expanded by 12%. The spring DFO RV trawl survey covers most of the stock and survey trends broadly reflect stock trends.

Maturation in female cod was estimated by cohort. The proportion of female cod maturing at younger ages has been higher for all cohorts subsequent to the 1986 cohort. The reasons for the change toward earlier age at maturity are not fully understood but may have a genetic component that is partly a response to high levels of mortality including fishing. Males generally mature about one year younger than females but show a similar trend over time.

Spawning is spatially widespread in 3Ps, occurring close to shore as well as on Burgeo Bank, St. Pierre Bank, and in the Halibut Channel. Timing of spawning is variable and extremely protracted, with spawning fish present from March until August in Placentia Bay. A recent review of spawning time (DFO, 2009) found no indication of any shift in the timing of spawning compared to previous observations.

Growth, calculated from length-at-age in research trawl survey samples, has varied over time. For ages older than age 3 there was a general decline in length-at-age from the early 1980s to the mid-1990s. For most ages there was an increase in length-at-age from the mid-1990s through the mid-2000s, but data from 2007-11 surveys suggest that mean length at age for ages 3-8 has been near average. Length-at-age for fish sampled in the sentinel survey has declined since 1998 in fish ages 4 and older.

Comparison of post-1992 **condition** with that observed during 1985-92 is difficult because survey timing has changed. Condition varies seasonally and tends to decline during winter and early spring. Body condition in 2011 was about average, while liver condition was below most of the values from 1997 to 2007. Seasonally, fish and liver condition observed in sampling from the sentinel surveys were higher in the fall and declined over the winter and early spring. Annually, trends in condition have varied, and sentinel sampling in 2010 indicates condition was near the time-series average.

ASSESSMENT

Resource Status

Sources of information:

Stock status was updated using **commercial landings** to September 2011, log-book data (1997-2010), **abundance indices** from Canadian research vessel (RV) trawl surveys (1972-2011), industry trawl surveys (1997-2005, 2007), and sentinel surveys (1995-2011). Results of telephone surveys of inshore fish harvesters from Canada and exploitation (harvest) rates estimated from tagging experiments in Placentia Bay were also available.

Research vessel surveys:

Canadian DFO RV bottom **trawl surveys** have been conducted since 1972. Surveys from 1972-82 had poor coverage. The surveyed area was increased by 12% during 1997 when inshore strata were added. The DFO RV survey was not completed in 2006 due to unforeseen operational difficulties with the vessels. Survey indices are presented for the expanded DFO survey area (inshore and offshore; denoted "Combined" in figures) as well as for the offshore strata ("Offshore" in figures). The DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Any near-shore aggregations in April would not be measured by the DFO RV survey. The majority of the area shore-ward of the DFO RV survey lies within inner and western Placentia Bay. There is no recent evidence that a large fraction of the stock is shore-ward of the DFO RV survey in April.

The **biomass index** from the offshore strata is variable but declined from the mid-1980s to the early 1990s (Fig. 3). Values for most of the post-moratorium period up to 2004 were higher than those of the early 1990s, but not as high as those of the 1980s. The survey index shows a general declining trend from 87,000 t in 2001 to 20,525 t in 2008. The subsequent trend is less clear. Values in both 2009 and 2010 are near average whereas the 2011 index value (30,475 t) is below average. In 2011, survey catches were highest on Burgeo Bank, the southern edge of the Hermitage Channel and the Halibut Channel, though the overall contribution from these areas was less than in many other years. Survey biomass from the combined index ("All Strata <300 fms") shows similar trends to the offshore only index.

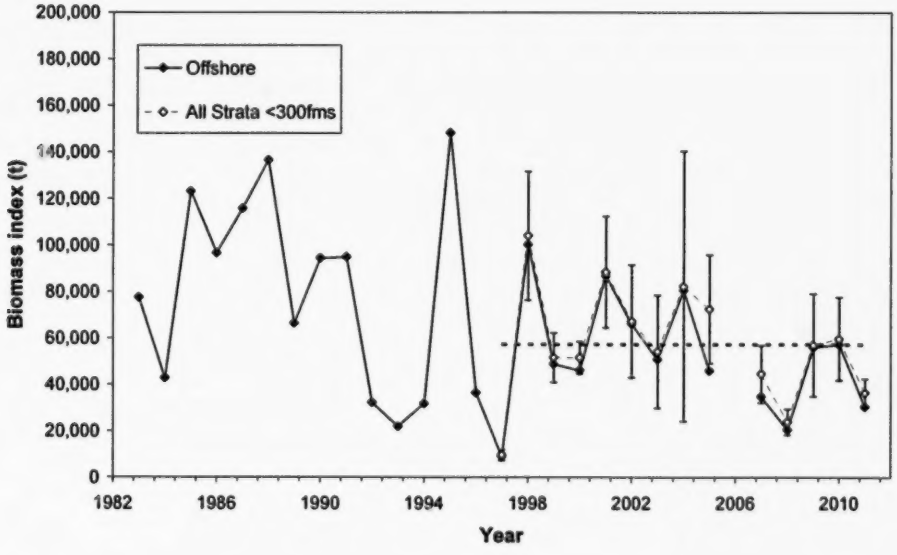

Fig. 3. Research vessel survey biomass indices (t) (error bars are 95% confidence intervals for combined survey index – dashed line is average of combined survey index).

An index of **mature (adult) biomass** was computed from the offshore survey (Fig. 4) and current values are below the time-series average.

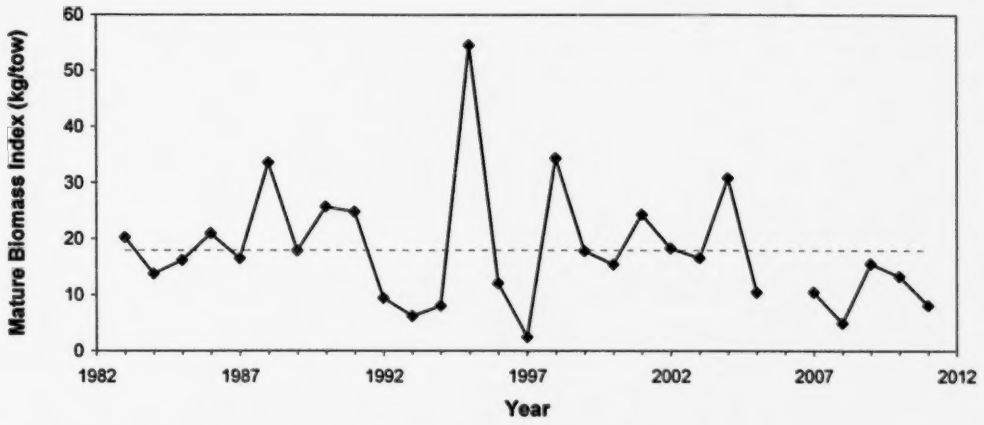

Fig. 4. Mature biomass index from DFO RV offshore survey. Dashed line is the time-series average.

The offshore DFO RV abundance index is variable, but values during the 1990s were generally lower than those from the 1980s (Fig. 5). The index generally declined from 88.25 million fish in 2001 to 38.65 million in 2008. Due to recruitment, the index increased to 88.49 million fish in 2010. The 2011 index value of 55.28 million fish is near the time-series average. The combined DFO RV abundance index shows similar trends to the offshore index.

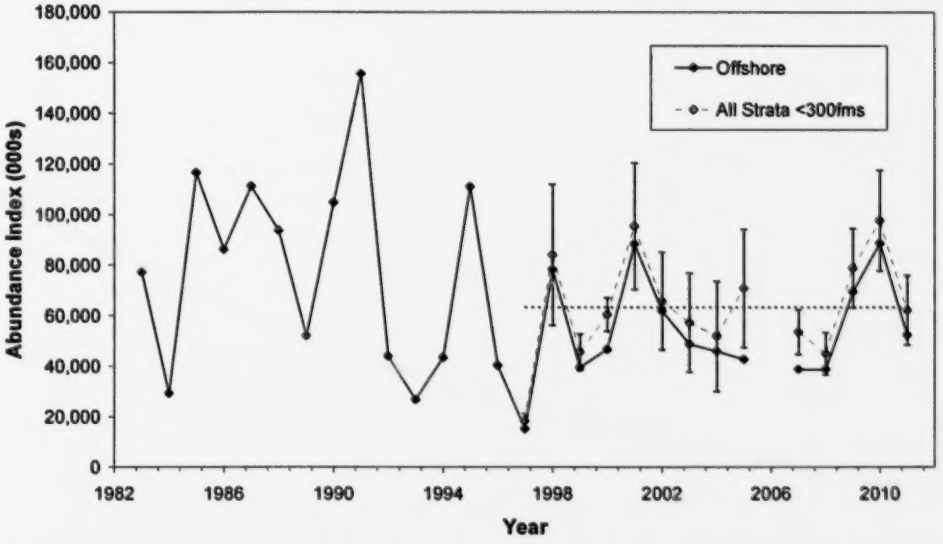

Fig. 5. Research vessel survey abundance indices (error bars are 95% confidence intervals for combined survey – dashed line is average of combined survey index).

Age composition:

Catches during the 2011 RV survey consisted mainly of cod aged 2-5 (81% of abundance index). The 2006 year-class, now five years old, was once again measured as above average compared to previous age 5 observations.

Cohort Analysis:

Spawning Biomass:

Cohort analyses (Cadigan, 2010) of the DFO RV data indicated that spawning stock biomass (SSB) declined by more than 60% over 2004-09 (Fig. 6). The basis for a limit reference point (LRP) for this stock is $B_{Recovery}$, defined as the lowest observed SSB from which there has been a sustained recovery. The 1994 value of SSB has been identified as the LRP for this stock (DFO, 2004). Median SSB was estimated to be below the LRP in 2008 and 2009. The SSB in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08).

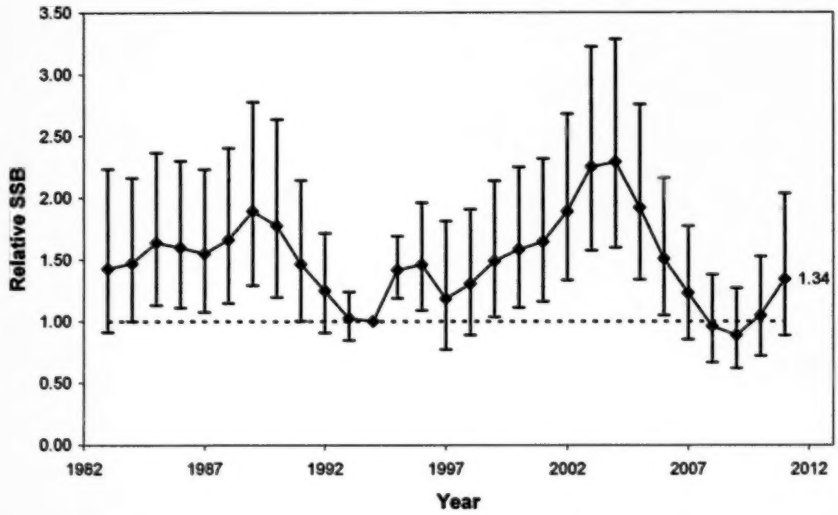

Fig. 6. Cohort analysis estimates of Survey Spawning Stock Biomass (SSB), relative to the 1994 value (median estimate with 95% confidence intervals). A horizontal dashed line at one (reference level) represents the SSB Limit Reference Point. Text label indicates the current SSB relative to the LRP.

Mortality rates:

Estimates of total mortality from the cohort model (Fig. 7) over 2006-10 (ages 5-10) averaged 0.68 (49% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

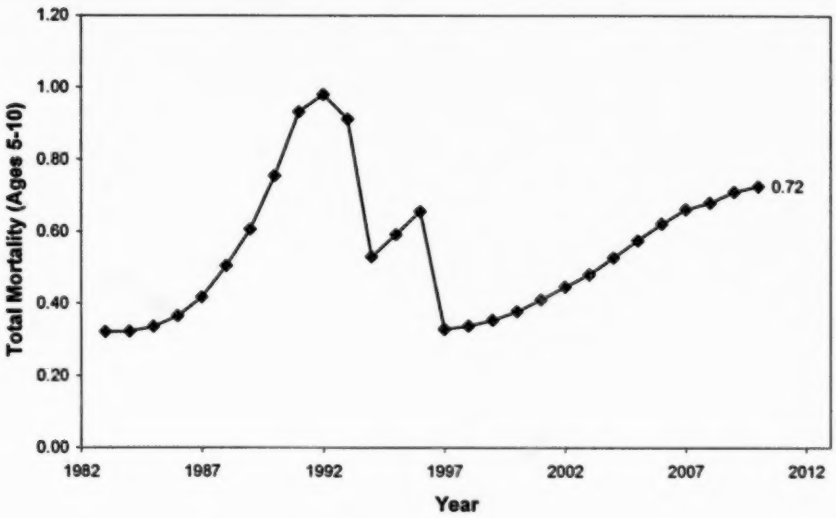

Fig. 7. Cohort analysis estimates of total mortality. Text label indicates the estimated total mortality for 2010.

This analysis assumes that age 4 and older fish are equally selected (flat-topped) by the RV survey. Alternate assumptions for the relative catchability (domed) of cod ages 4+ were also explored in recent assessments and gave similar trends (see DFO, 2009). Flat-topped selectivity is commonly assumed unless there is evidence otherwise.

Recruitment:

Estimates of recruitment (age 1) from the cohort model indicate that the 2006 cohort is estimated to be relatively strong and is expected to recruit to the 2011 fishery. Subsequent year-classes are near the series average, except for the estimate of the 2010 year-class, presently estimated to be the lowest over the full time-series. The most recent estimates of recruitment are subject to future revision as additional data is collected on these year-classes as they age. Most year-classes currently supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts.

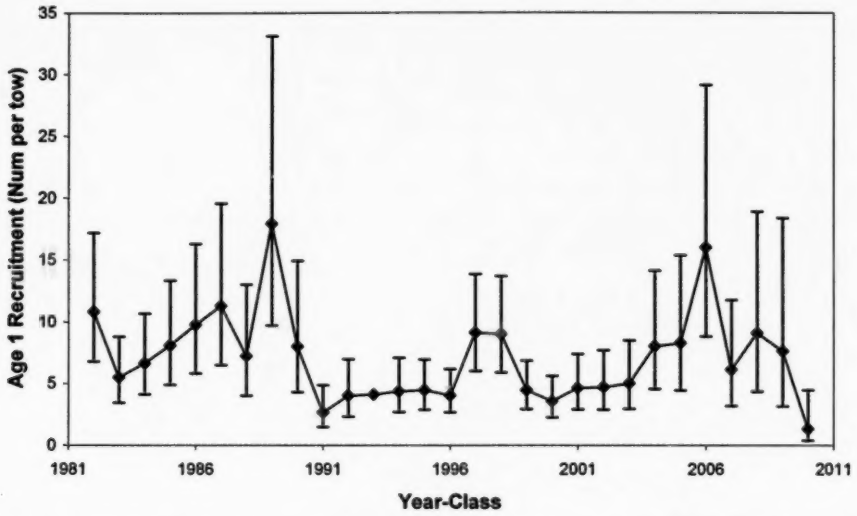

Fig. 8. Estimated relative year-class strength from cohort model (with 95% confidence interval).

Projection:
A one year projection to 2012 using the cohort model indicated that survey SSB will increase if total mortality rates are similar to current values (i.e., within ±20%), and that the probability of being below the LRP in 2011 is low (0.02 to 0.09). Three year projections to 2014 indicate subsequent declines in both total biomass and spawning biomass if total mortality is similar (i.e., within ±20%) to current values. In 2014 the probability of being below the LRP ranges from 0.03 to 0.56.

Sentinel survey:

Fixed gear **sentinel surveys** have been conducted at sites along the south coast of Newfoundland from St. Bride's to Burgeo from 1995 through 2010. Gillnet results come mostly from sites in Placentia Bay whereas line-trawl results come mostly from sites west of the Burin Peninsula. The sentinel survey for 2011 is still ongoing; hence, the data for 2011 are incomplete and were not included in the modeling reported below.

The sentinel survey data were standardized to remove site and seasonal effects to produce annual indices of the total and age-specific catch rates.

The standardized total annual **catch rate** for gillnets was high from 1995-97, but progressively lower in 1998 and 1999, and remained quite low from 2000 to 2010 (Fig. 8, upper panel). The line-trawl catch rates were high in 1995 with a steady decline to 1999, but have subsequently been fairly constant through 2009 (Fig. 8, lower panel). The 2010 line-trawl catch rate estimates are the lowest in the time-series. Although considerable declines have been measured by both gear types, the magnitude of this decline is inconsistent across gear types. Current gillnet estimates are 9% of the 1995-97 average, whereas current line-trawl values are 34% of the first two estimates.

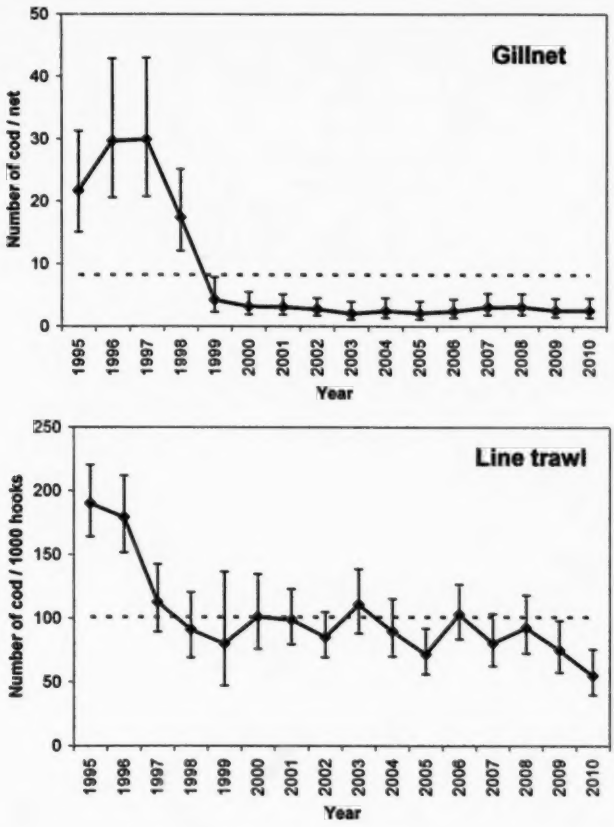

Fig. 9. Standardized sentinel catch rates for gillnets (upper panel) and line-trawls (lower panel). Error bars are 95% confidence intervals; dashed lines represent the time-series average.

Comparison of sentinel catch rates and the DFO RV index at times show inconsistent age-compositions. This may be indicative of differences in cohort strength between stock components.

Age composition:
The standardized age-specific catch-rates for gillnets and line-trawls show similar trends with the relatively strong 1989 and 1990 year-classes being replaced by subsequent weaker year-classes resulting in an overall decline in catch rates. Although the magnitude of the sentinel catch-rates has been generally constant for more than a decade, the 1997 and 1998 year-classes were consistently evident in both age disaggregated sentinel indices. In addition, the 2004 year-class appears to be well-represented only within line-trawl results.

Log books:
There is considerable uncertainty in the interpretation of fishery catch rate data. These data may be more reflective of changes in the nature of the fishery than changes in population size.

<35' Vessels:
Standardized annual catch rates from science log books (<35' sector) for vessels fishing gillnets show a declining trend during 1998-2000, but have subsequently been fairly

constant (Fig. 9, upper panel). A declining trend during 1997-99 was observed for line-trawls, followed by stable catch rates to 2002 and an increase in 2004-06 (Fig. 9, lower panel). Catch rates have since declined and the 2010 catch rate is approximately equal to the time-series average. The commercial index is based on weight of fish caught whereas the sentinel index is based on numbers. As with the sentinel results, there is contrast between the two gear-types in current catch rates relative to the beginning of the time-series. Compared to the average CPUE in 1997 and 1998, current gillnet CPUE is 50% lower, whereas the 2009 linetrawl CPUE is only about 15% below the initial values. Traditionally most gillnet effort was within the eastern part of the stock area; similarly linetrawl was the dominant gear in western 3Ps. However, based upon the logbooks returned in 2009 and 2010, gillnet activity was equally spread between eastern and western 3Ps, due to significant reductions in effort throughout eastern 3Ps. Due to reductions in the return rate of these logbooks over time, it is unclear if these trends reflect the fishery as a whole.

The percentage of the catch from the <35' sector that is accounted for in the standardized logbook indices has declined over time and now represents less than 30% of the catch as compared to approximately 70% at the start of the time series in 1997. This likely affects the quality, and comparability, of this index over time.

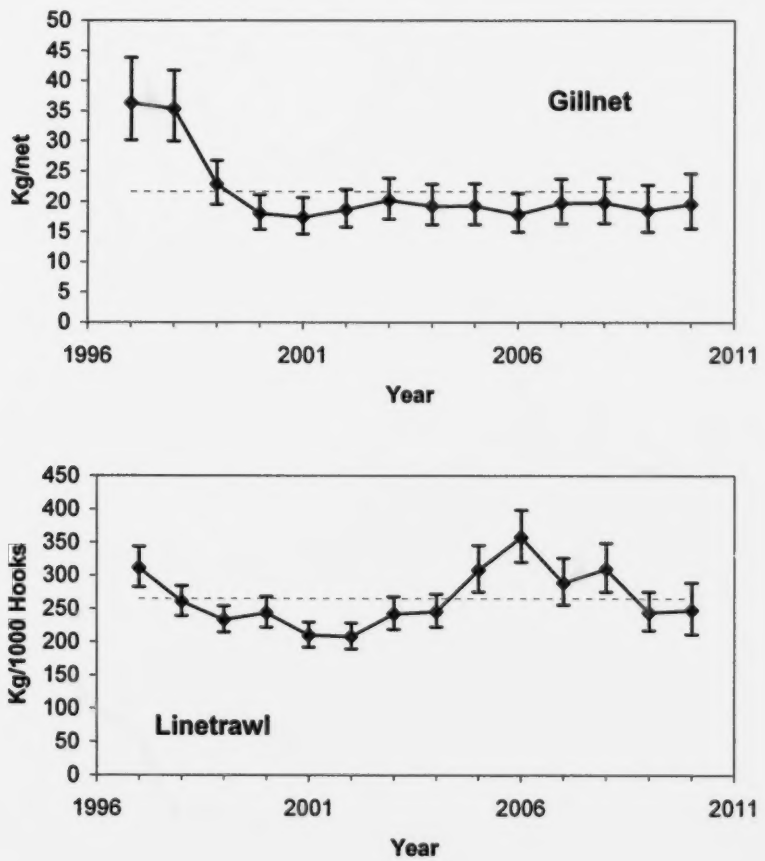

Fig. 10. Standardized catch rates for gillnets and line-trawls from science log books for vessels <35'. Error bars are 95% confidence intervals; dashed line is the time-series average.

Tagging:
During 2008-10, tagging was conducted in Placentia Bay in spring (May-June). Although exploitation rates based on tagging of cod in Placentia Bay may not be applicable to other areas, or to the stock as a whole, this area accounts for a significant portion (~ 30%) of the overall annual landings from the stock.

Exploitation rates for 2010 based on tagged cod released in Placentia Bay ranged from 28-33% for large cod (>65 cm) and 10-17% for smaller cod (<65 cm). Estimates of exploitation rates from tagging can be influenced by the sizes of cod tagged due to selectivity of commercial fishing gear. Larger cod (>65 cm) tend to be more readily selected by gill nets compared with smaller ones.

Release of tagged cod has been reduced in recent years and exploitation rates based on tagging are no longer available for the offshore (Halibut Channel and Burgeo Bank), Fortune Bay, or Hermitage Bay.

Sources of Uncertainty

The level of total removals is uncertain. It is likely that historical landings have been biased both upwards (e.g., due to misreporting of catch by area and/or species) and downwards (e.g., due to discarding). In addition, commercial catch accounting procedures pre- and post-moratorium are radically different, with current measures likely to provide improved estimates of removals. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium. Estimates of recreational fishery landings have not been available since 2006.

There is uncertainty regarding the origins of fish found in 3Ps at various times of the year. Tagging and telemetry experiments show that there is mixing with adjacent stocks (southern 3L and 3Pn4RS) and this may vary over time.

The DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Any near-shore aggregations in April would not be measured by the DFO RV survey. The majority of the area shore-ward of the DFO RV survey lies within inner and western Placentia Bay. There is no recent evidence that a large fraction of the stock is shore-ward of the DFO RV survey in April.

There is evidence that the recruitment productivity of the stock has changed over time, and that the stock has been less productive since 1990 than in earlier periods. The causes for these changes are not well understood. Better understanding of this issue is required and could have important implications for any management targets and MSY reference points. This reduction in recruitment productivity may be consistent with harvester perspective on the declining abundance of capelin in 3Ps.

Comparison of sentinel catch rates and the DFO RV index at times show inconsistent age-compositions. This may be indicative of differences in cohort strength between stock components. For example, the sentinel gillnet data consistently measured the 1992 cohort as being an above average fraction of the annual catch. This cohort was also important to the commercial gillnet catch, but was not notable in the DFO RV index. A similar phenomenon exists for the 2004 cohort (detected by sentinel linetrawl but not sentinel gillnet or DFO RV index).

The geographical coverage of tagging since 2007 is very limited; during 2008-10 cod have only been tagged in Placentia Bay. The lack of recent tagging in other areas adds uncertainty to our understanding of natural mortality rates, exploitation rates, stock structure, and movement patterns and how these influence survey and commercial catch rates in the recent period.

The relative efficiency of the survey trawl at capturing different age groups is uncertain. Differing patterns of catchability were explored in recent assessments and yielded similar outcome in terms of current status relative to the LRP. If the catchabilities differ from the assumed values, stock dynamics may differ from the results presented above.

Survey indices are at times influenced by "year-effects", an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. In the 2009 DFO RV survey, the estimated abundance at ages 2-8 increased compared to these cohorts at ages 1-7 as measured in the 2008 survey. This is unusual and indicates that one (or possibly both) of the 2008 and 2009 surveys may be influenced by a year-effect. Year-effects are also evident in the 1995 and 1997 survey results.
The percentage of the catch from the <35' sector that is accounted for in the standardized logbook indices has declined over time and now represents only about 30% of the catch as compared to approximately 70% at the start of the time series in 1997. This likely affects the quality and comparability of this index over time.

Age at 50% maturity has been declining in recent years. The proportion of female cod maturing at younger ages has been higher for all cohorts subsequent to the 1986 cohort, resulting in a significant proportion of SSB made up of younger fish. Questions exist as to whether or not these small, young fish are effective spawners. Given the lack of definitive data regarding size and age effects on spawner quality for this stock, the current practice of equally weighting all components of SSB (regardless of size and age) continues to be employed. However, if young spawners contribute disproportionately less to recruitment than older fish, the current reproductive potential of the stock would be lower than expected and would be reduced in comparison to the pre-1986 SSB, which was comprised of older fish.

ADDITIONAL STAKEHOLDER PERSPECTIVES

As in 2009, fishing effort during the 2010 fishing season was reduced due to the low price per pound and increased bait and fuel costs. Fish Harvesters are concerned about the very low abundance of capelin and the impact it is having on cod migration and the longer term negative impacts the low abundance of this most important food source will have on the overall health and reproduction of cod. In some areas sightings of grey seals have increased and there is a growing concern about the negative impacts that this may be having on cod abundance.

To provide a fish harvester perspective on the results of the 2010 fishery, a telephone survey was conducted by the FFAW during February of 2011. Most fish harvesters felt that 2010 abundance was about the same or less when compared to 2009. Fish harvesters were asked to rate their 2010 catch rates in comparison to his/her historical perspective. With 1 being the worst and 10 being the best, most responses were from 5 to 8. The size range of cod in 2010 was about the same or smaller than during 2009. The condition of cod was good. Fish harvesters felt that the 2010 abundance level of capelin and squid was low and declining.

Fish harvesters in the >20m vessel sector, during the 2010 -11 fishing season saw a decline in the abundance of older (larger) fish in the offshore catch, down from the previous winter season.

They also saw evidence of the reasonably strong 2006 year-class in their catches. On average catch rates in the offshore fishery were good but there were fewer sea-days with very high catch rates. Competition with fixed gear vessels for traditional offshore fishing grounds and variable weather conditions were factors affecting reduced catch rates. The number of fishing trips for cod by the offshore sector by mobile vessels greater than 33 m during January and February were limited by labour disruptions.

CONCLUSIONS AND ADVICE

The assessment concluded from tagging data and ancillary information that the complex of stock components exploited by fisheries in 3Ps does not comprise a single stock for which population biomass and abundance can be estimated from existing information. Therefore the impacts of fishing at specific TAC levels on all stock components could not be quantified. However, the DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Indices based on the research vessel (RV) survey have been used to assess current status of the stock relative to historic observations and to evaluate growth and sustainability of the stock.

A limit reference point (LRP, $B_{Recovery}$) was identified for this stock during the 2004 assessment (DFO, 2004). It is defined as the lowest observed spawning stock biomass (SSB) from which there has been a sustained recovery; the 1994 value of SSB has been identified as the LRP.

SSB decreased over the 2004-09 period. Median SSB was estimated to be below the LRP in 2008 and 2009. The SSB in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08). A one year projection to 2012 using the cohort model indicated that survey SSB will continue to increase if total mortality is similar to current values (i.e., within ±20%). This increase is due to the recruitment of the relatively strong 2006 year class (YC) to the spawner biomass. The projection also indicated that the probability of being below the LRP in 2012 is low (0.02 to 0.09). A three year projection to 2014 indicates subsequent declines in both total biomass and spawning biomass if total mortality is similar to current values (i.e., within ±20%). In 2014 the probability of being below the LRP ranges from 0.03 to 0.56.

The 2006 cohort is estimated to be relatively strong and is expected to recruit to the 2011 fishery. The 2007 to 2009 cohorts are estimated to be near the 1982-2010 average.

Estimates of total mortality (ages 5-10) over 2006-10 averaged 0.68 (49% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

Exploitation rates for 2010 based on tagged cod released in Placentia Bay ranged from 28-33% for large cod (>65cm) and 10-17% for smaller cod (<65cm).

Gillnet catch rates from both sentinel surveys and logbooks for vessels <35' suggest stability. However, linetrawl catch rates from these sources indicate recent decline.

Overall, the findings of the current assessment are consistent with those of previous assessments. The 3Ps cod SSB at the beginning of 2011 was estimated to be above the LRP.

Provisional work demonstrated substantial uncertainty in estimates of B_{MSY} and F_{MSY}. Progress toward these estimates will require further research on unresolved issues. At this time, these uncertainties preclude long-term projections to determine the time required to reach B_{MSY}.

Management Considerations

The level of total removals is uncertain but less so in the post-moratorium period. In assessing stock status, it would be useful to better understand the accuracy of total removals. Accurate estimates of recreational fishery landings are also required.

Estimation of MSY-based reference points (F_{MSY} and B_{MSY}) for the 3Ps cod stock will require an assessment framework review including further peer review of the modeling approach used to quantify these reference points.

The implementation of trip limits, price differentials based on size, and individual quotas (IQ's), are all potential incentives for discarding and high-grading of catches. Recent investigations into this problem have identified that high-grading has occurred, but the quantity has not been determined. Quantifying discards would improve the understanding of stock productivity. This is an unaccounted source of fishing mortality.

Management should recognize that cod which overwinter in 3Ps are also exploited in adjacent stock areas (Division 3L and Subdivision 3Pn). Hence management actions in these stock areas should consider potential impacts on 3Ps cod.

Recent results confirmed that closures to protect spawning or mixed-stock aggregations are appropriate.

Consequences of area/time closures should be carefully considered as these may result in higher exploitation rates on the components of the stock that remain open to fishing. The fishery should be managed such that catches are not concentrated in ways that result in high exploitation rates on any stock components.

Management should be aware of within-year variations in the individual weight of cod. Greatest yield can be gained when fish are in peak condition, typically in late fall/early winter, while minimizing the number of individuals removed from the stock.

OTHER CONSIDERATIONS

Temperature

Oceanographic information collected during the spring DFO RV surveys indicated that near-bottom temperatures throughout NAFO subdivision 3Ps have been warmer during 2009-11 increasing to above normal values. As an example, the area of <0°C water during spring has was near 0% in 2011, compared to almost 30% in 2007 and 2008. Survey catches of cod are generally lower in years when there are relatively large incursions of cold/fresh water from the eastern NL shelf. Furthermore, a significant positive correlation was found between bottom temperature and the survey abundance of cod in depths of 100 m or less. The areal extent of bottom water with temperatures >3°C has remained relatively constant at about 50% of the total 3P area, although actual temperature measurements show considerable inter-annual variability. The current conditions are comparable to those of the late 1970's and early 1980's when the stock was more productive.

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of October 25-28, 2011 on the Atlantic Cod in Subdivision 3Ps. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www. dfo-mpo.gc.ca/csas-sccs/index-eng. htm.

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